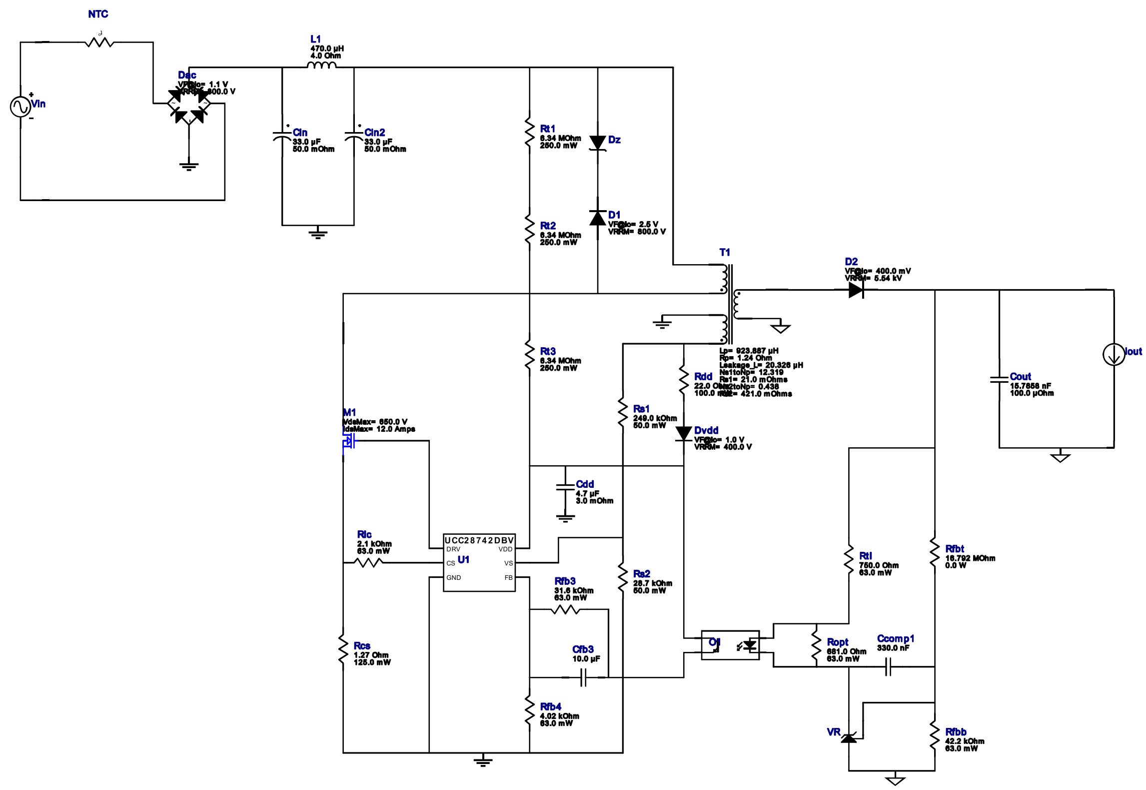
VinMin = 85.0V
VinMax = 265.0V
Vout = 1000.0V
Iout = 0.01A

Device = UCC28742DBVR
Topology = Flyback
Created = 2024-04-16 12:45:54.675
BOM Cost = NA
BOM Count = 34
Total Pd = 1.53W

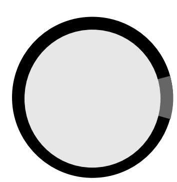
WEBENCH ® Design Report

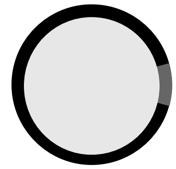
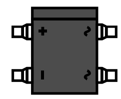
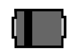
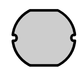
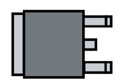
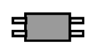
Design : 17 UCC28742DBVR
UCC28742DBVR 85V-265V to 1000.00V @ 0.01A



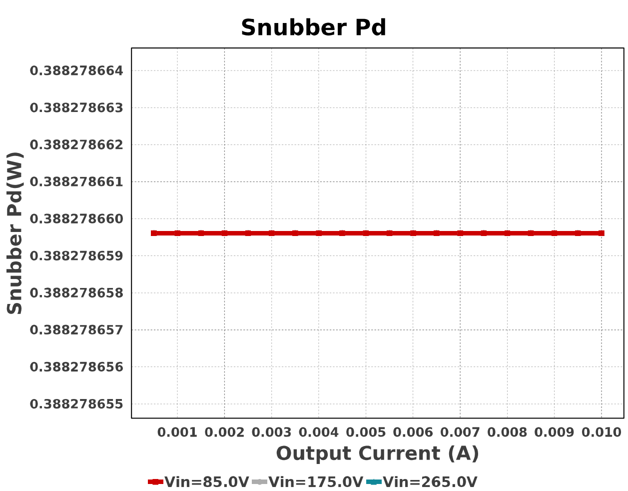
1. Rlc, Rtl and the feedback resistors for this design are a starting point, but may need adjustment based on the actual transformer used. For more information please click the design assistance button.

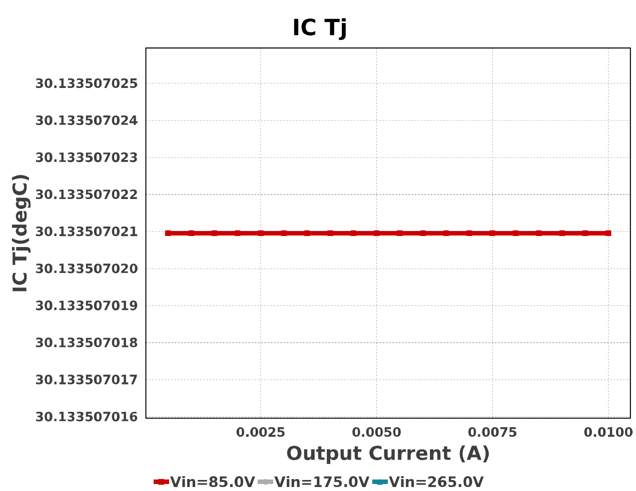
Electrical BOM

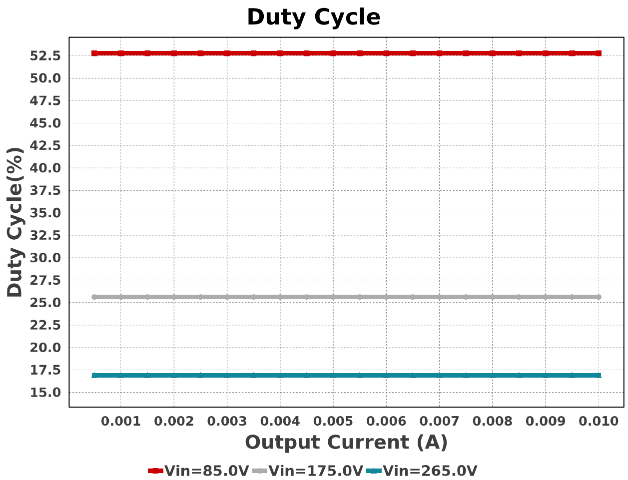
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Ccomp1	Panasonic	ECPU1C334MA5 Series= ECPU(A)	Cap= 330.0 nF VDC= 16.0 V IRMS= 0.0 A	1	$0.23	 1206 11 mm²
Cdd	MuRata	GRM31CR71H475KA12L Series= X7R	Cap= 4.7 uF ESR= 3.0 mOhm VDC= 50.0 V IRMS= 4.98 A	1	$0.10	 1206 11 mm²
Cfb3	MuRata	GRM188Z71A106MA73D Series= X7R	Cap= 10.0 uF VDC= 10.0 V IRMS= 0.0 A	1	$0.06	0603 5 mm²
Cin	Nichicon	UPW2G330MHD Series= PW	Cap= 33.0 uF ESR= 50.0 mOhm VDC= 400.0 V IRMS= 140.0 mA	1	$0.86	 CAPPR7.5-16X25 324 mm²

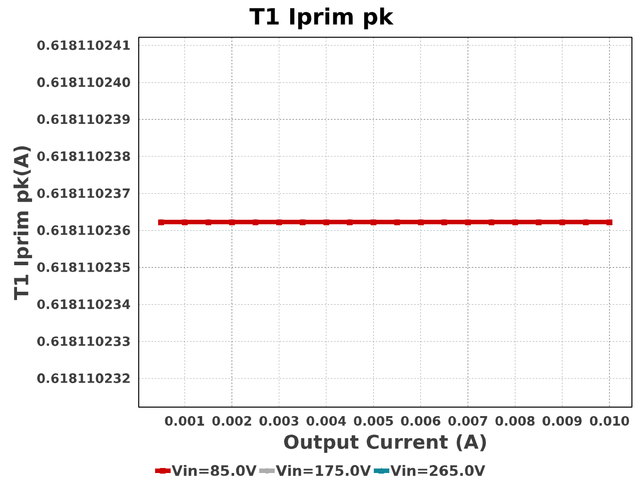
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Cin2	Nichicon	UPW2G330MHD Series= PW	Cap= 33.0 uF ESR= 50.0 mOhm VDC= 400.0 V IRMS= 140.0 mA	1	$0.86	 CAPPR7.5-16X25 324 mm²
Cout	CUSTOM	CUSTOM Series= ?	Cap= 15.7858 nF ESR= 100.0 uOhm VDC= 1.5 kV IRMS= 16.3127 mA	1	NA	CUSTOM 0 mm²
D1	Bourns	CD1408-FU1800	VF@Io= 2.5 V VRRM= 800.0 V	1	$0.14	 Diode_1408 13 mm²
D2	CUSTOM	CUSTOM	VF@Io= 400.0 mV VRRM= 5.54 kV	1	NA	CUSTOM 0 mm²
Dac	Vishay-Semiconductor	DF08SA	VF@Io= 1.1 V VRRM= 800.0 V	1	$0.28	 DF-S 99 mm²
Dvdd	SMC Diode Solutions	UF4004TA	VF@Io= 1.0 V VRRM= 400.0 V	1	$0.04	 DO-41 43 mm²
Dz	Diodes Inc.	SMBJ110A-13-F	Zener	1	$0.10	 SMB 44 mm²
L1	NIC Components	NPI54C471KTRF	L= 470.0 µH 4.0 Ohm	1	$0.09	 IND_NPI54C 61 mm²
M1	STMicroelectronics	STD16N65M5	VdsMax= 650.0 V IdsMax= 12.0 Amps	1	$1.91	 DPAK 102 mm²
NTC	GE Sensing	CL-40 Series= CL	Thermistor	1	$0.86	 Thermistor_CL-40 164 mm²
O1	California Eastern Laboratories	PS2811-1	Optocoupler	1	$1.17	 SSOP-4 111 mm²
Rcs	Vishay-Dale	CRCW08051R27FKEA Series= CRCW..e3	Res= 1.27 Ohm Power= 125.0 mW Tolerance= 1.0%	1	$0.01	0805 7 mm²
Rdd	Yageo	RC0603FR-0722RL Series= ?	Res= 22.0 Ohm Power= 100.0 mW Tolerance= 1.0%	1	$0.01	0603 5 mm²
Rfb3	Vishay-Dale	CRCW040231K6FKED Series= CRCW..e3	Res= 31.6 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfb4	Vishay-Dale	CRCW04024K02FKED Series= CRCW..e3	Res= 4.02 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbb	Vishay-Dale	CRCW040242K2FKED Series= CRCW..e3	Res= 42.2 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rfbt	CUSTOM	CUSTOM Series= ?	Res= 16.792 MOhm Power= 0.0 W Tolerance= 0.0%	1	NA	CUSTOM 0 mm²
Rlc	Vishay-Dale	CRCW04022K10FKED Series= CRCW..e3	Res= 2.1 kOhm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²

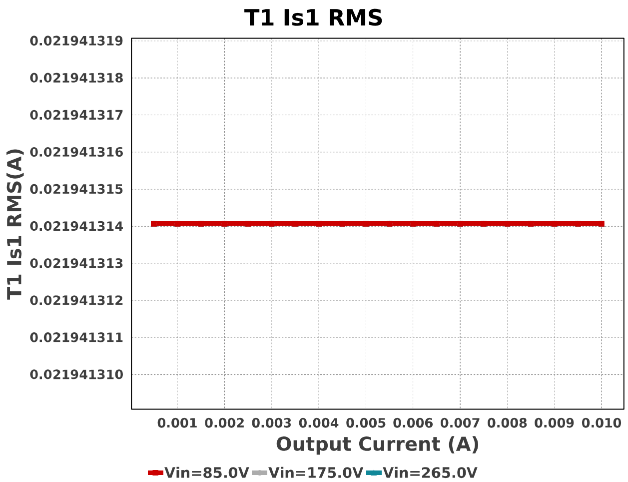
Name	Manufacturer	Part Number	Properties	Qty	Price	Footprint
Ropt	Vishay-Dale	CRCW0402681RFKED Series= CRCW..e3	Res= 681.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
Rs1	Yageo	RC0201FR-07249KL Series= ?	Res= 249.0 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Rs2	Yageo	RC0201FR-0728K7L Series= ?	Res= 28.7 kOhm Power= 50.0 mW Tolerance= 1.0%	1	$0.01	0201 2 mm²
Rt1	Vishay-Dale	CRCW12066M34FKEA Series= CRCW..e3	Res= 6.34 MOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm²
Rt2	Vishay-Dale	CRCW12066M34FKEA Series= CRCW..e3	Res= 6.34 MOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm²
Rt3	Vishay-Dale	CRCW12066M34FKEA Series= CRCW..e3	Res= 6.34 MOhm Power= 250.0 mW Tolerance= 1.0%	1	$0.01	1206 11 mm²
Rtl	Vishay-Dale	CRCW0402750RFKED Series= CRCW..e3	Res= 750.0 Ohm Power= 63.0 mW Tolerance= 1.0%	1	$0.01	0402 3 mm²
T1	CUSTOM	CUSTOM	Lp= 923.887 µH Rp= 1.24 Ohm Leakage_L= 20.326 µH Ns1toNp= 12.319 Rs1= 21.0 mOhms Ns2toNp= 0.438 Rs2= 421.0 mOhms	1	NA	CUSTOM 0 mm²
U1	Texas Instruments	UCC28742DBVR	Switcher	1	$0.24	R-PDSO-G6 10 mm²
VR	Texas Instruments	TL431IDBVR	Voltage References	1	$0.05	R-PDSO-G3 16 mm²

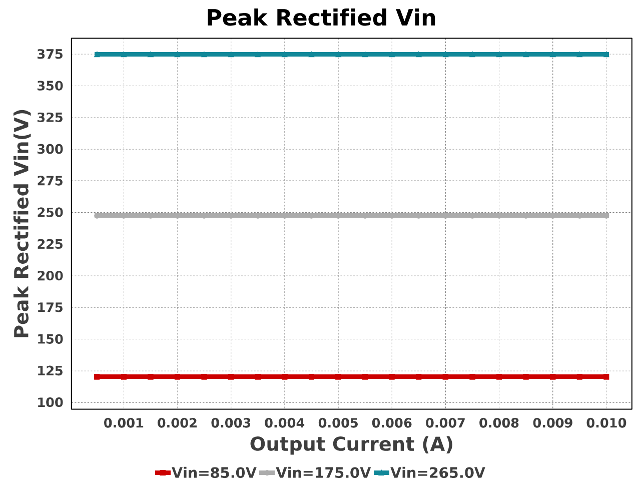


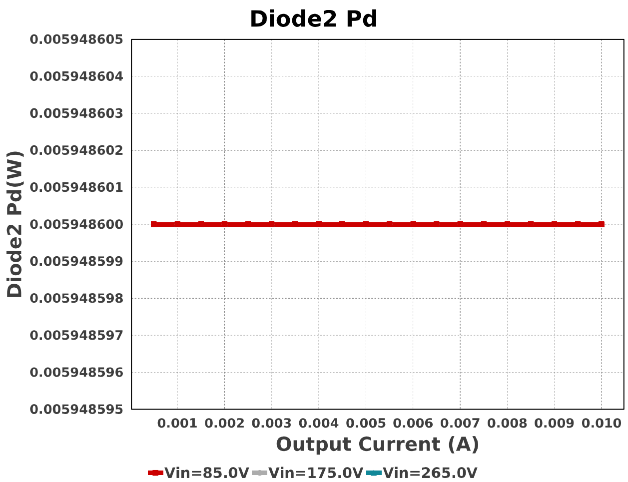


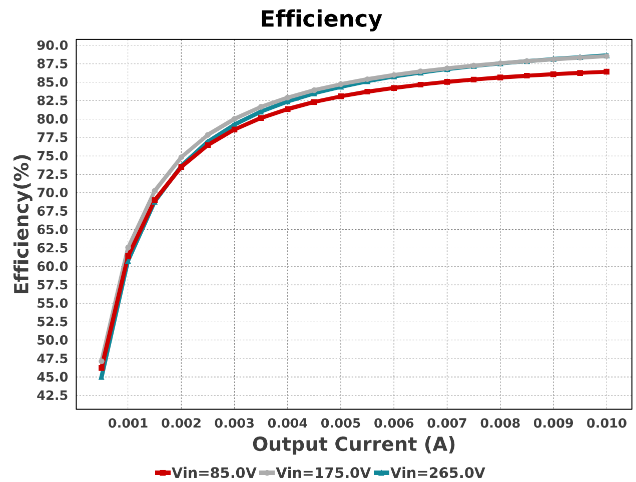

Duty Cycle
Duty Cycle(%)
52.5 50.0 47.5 45.0 42.5 40.0 37.5 35.0 32.5 30.0 27.5 25.0 22.5 20.0 17.5 15.0
0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.010
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

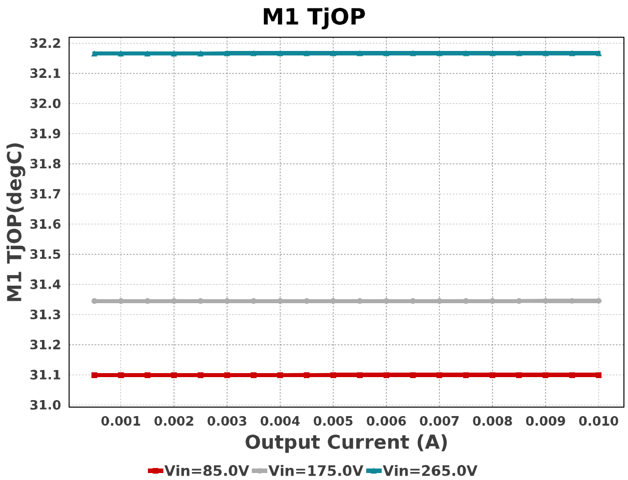

T1 Iprim pk
T1 Iprim pk(A)
0.618110241 0.618110240 0.618110239 0.618110238 0.618110237 0.618110236 0.618110235 0.618110234 0.618110233 0.618110232
0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.010
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

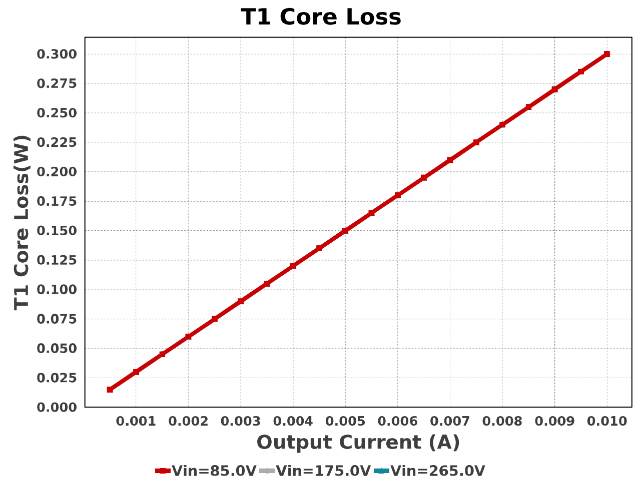

T1 Is1 RMS
T1 Is1 RMS(A)
0.021941319 0.021941318 0.021941317 0.021941316 0.021941315 0.021941314 0.021941313 0.021941312 0.021941311 0.021941310
0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.010
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

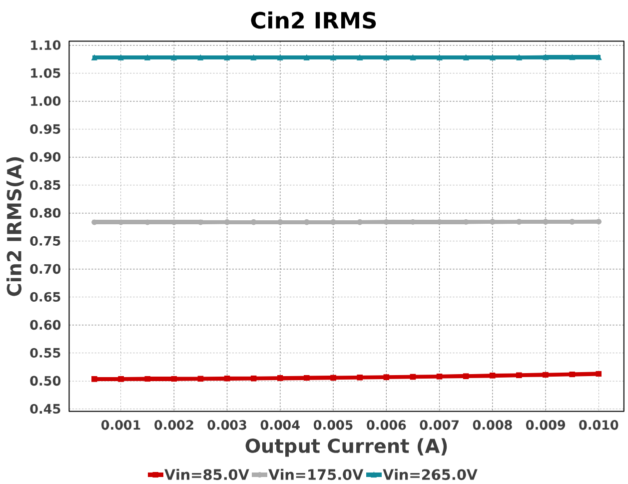

Peak Rectified Vin
Peak Rectified Vin(V)
375 350 325 300 275 250 225 200 175 150 125 100
0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.010
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

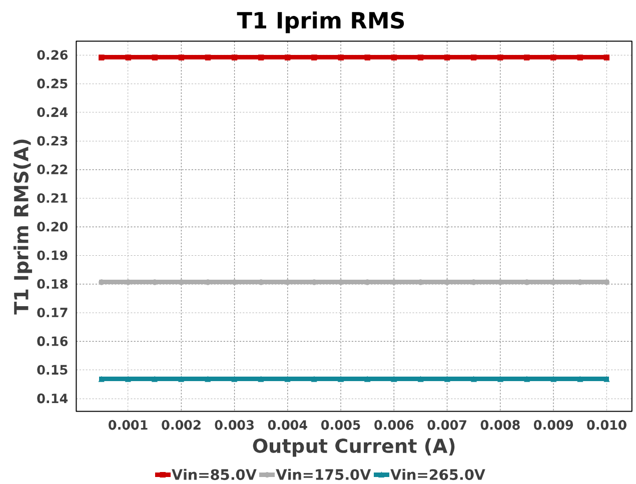

Diode2 Pd
Diode2 Pd(W)
0.005948605 0.005948604 0.005948603 0.005948602 0.005948601 0.005948600 0.005948599 0.005948598 0.005948597 0.005948596 0.005948595
0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.010
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

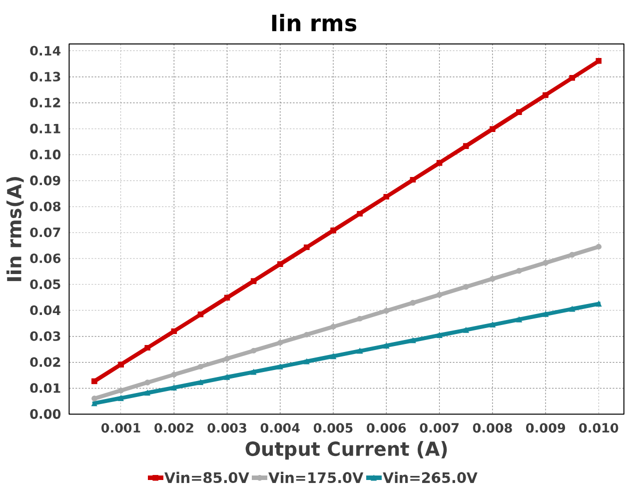

Efficiency
Efficiency(%)
90.0 87.5 85.0 82.5 80.0 77.5 75.0 72.5 70.0 67.5 65.0 62.5 60.0 57.5 55.0 52.5 50.0 47.5 45.0 42.5
0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.010
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

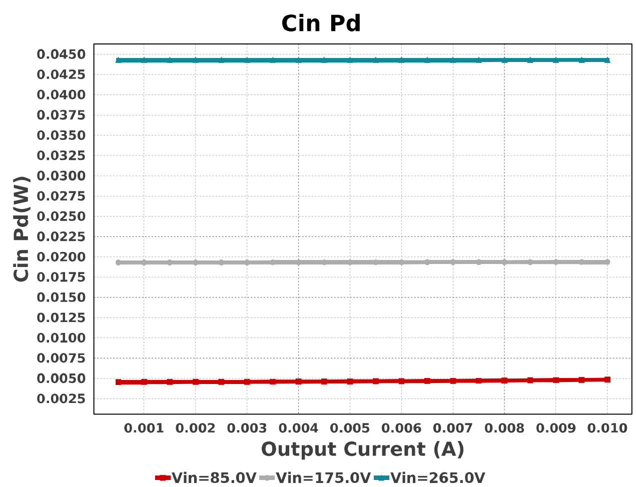

M1 TjOP
M1 TjOP(degC)
32.2
32.1
32.0
31.9
31.8
31.7
31.6
31.5
31.4
31.3
31.2
31.1
31.0
0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.010
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

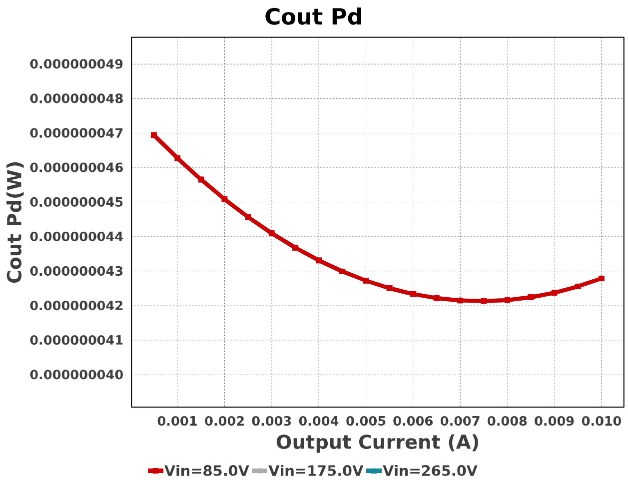

T1 Core Loss
T1 Core Loss(W)
0.300
0.275
0.250
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.010
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

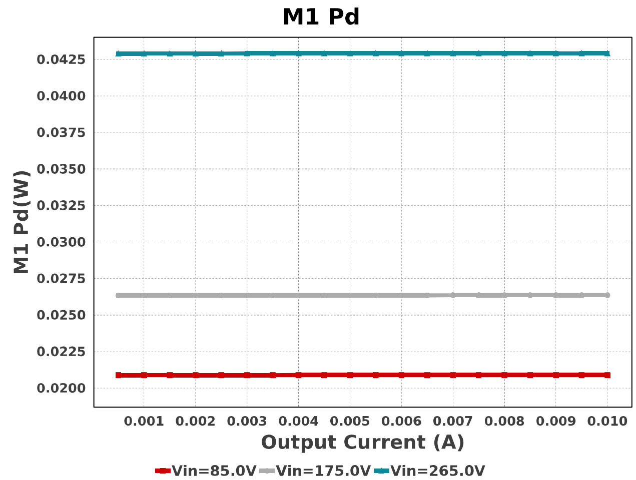

Cin2 IRMS
Cin2 IRMS(A)
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
0.65
0.60
0.55
0.50
0.45
0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.010
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

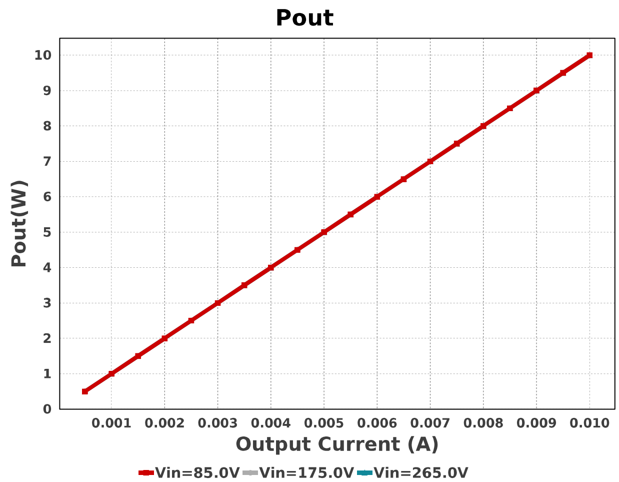

T1 Iprim RMS
T1 Iprim RMS(A)
0.26
0.25
0.24
0.23
0.22
0.21
0.20
0.19
0.18
0.17
0.16
0.15
0.14
0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.010
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

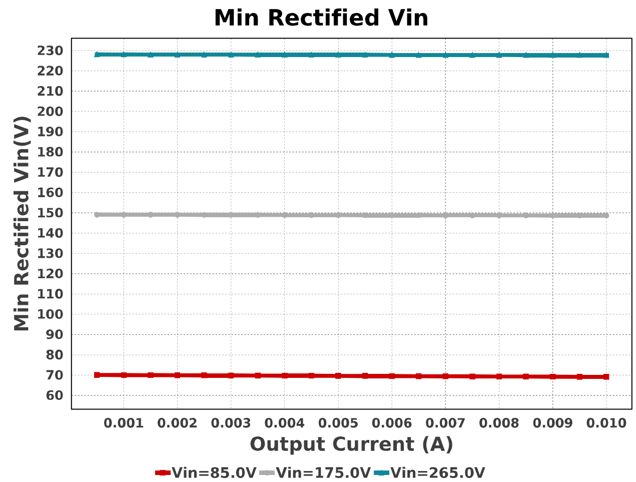

Iin rms
Iin rms(A)
0.14
0.13
0.12
0.11
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.010
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

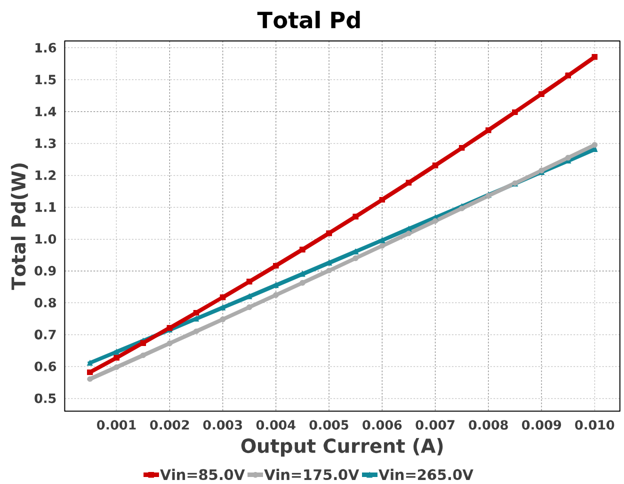

Cin Pd
Cin Pd(W)
0.0450
0.0425
0.0400
0.0375
0.0350
0.0325
0.0300
0.0275
0.0250
0.0225
0.0200
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.010
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

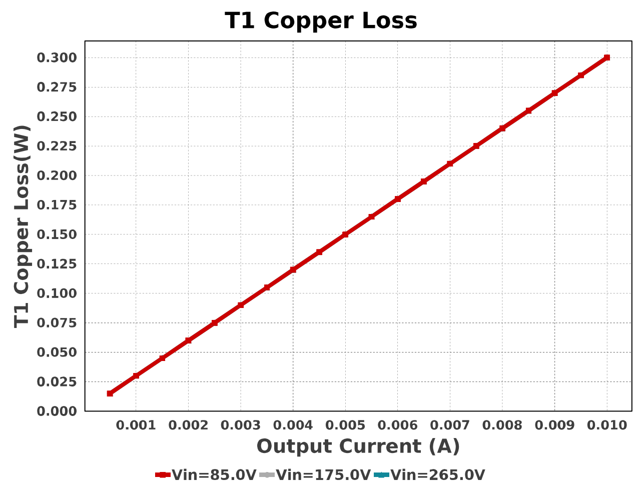

Cout Pd
Cout Pd(W)
0.000000049
0.000000048
0.000000047
0.000000046
0.000000045
0.000000044
0.000000043
0.000000042
0.000000041
0.000000040
0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.010
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

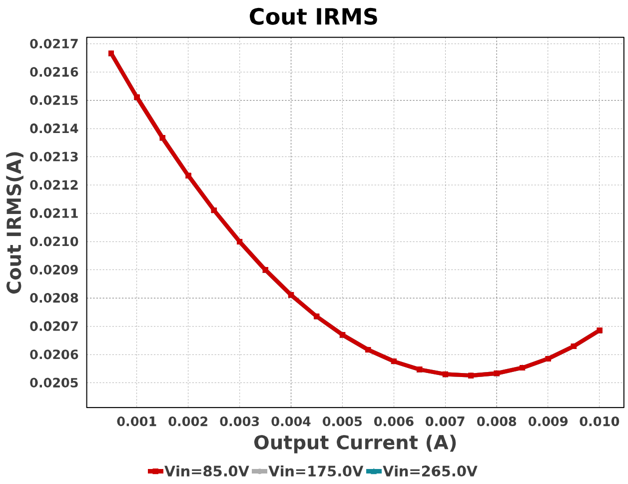

M1 Pd
M1 Pd(W)
0.0425
0.0400
0.0375
0.0350
0.0325
0.0300
0.0275
0.0250
0.0225
0.0200
0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.010
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

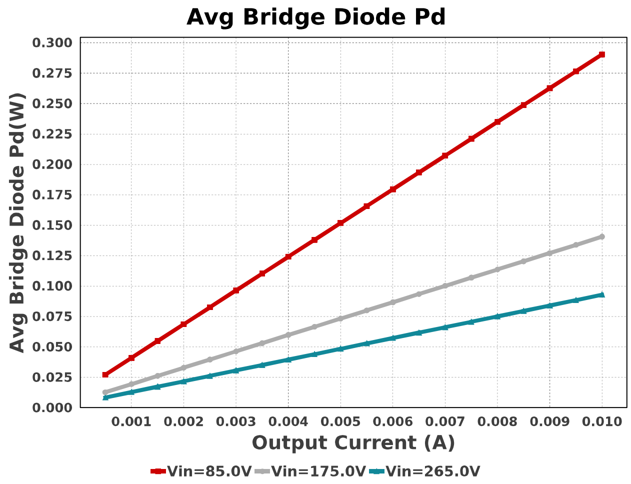

Pout
Pout(W)
10 9 8 7 6 5 4 3 2 1 0
0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.010
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

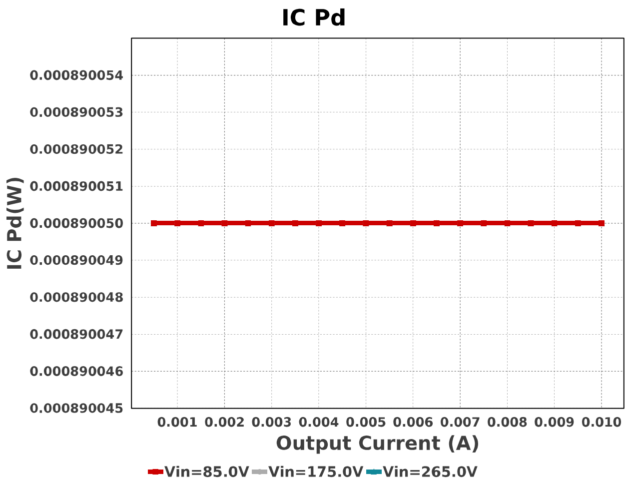

Min Rectified Vin
Min Rectified Vin(V)
230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60
0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.010
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

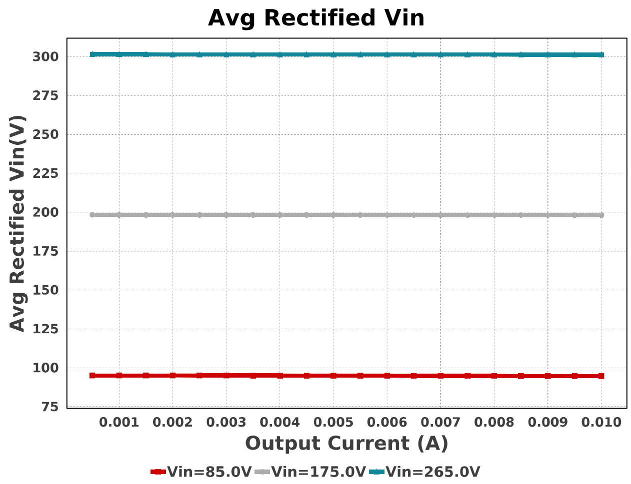

Total Pd
Total Pd(W)
1.6 1.5 1.4 1.3 1.2 1.1 1.0 0.9 0.8 0.7 0.6 0.5
0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.010
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

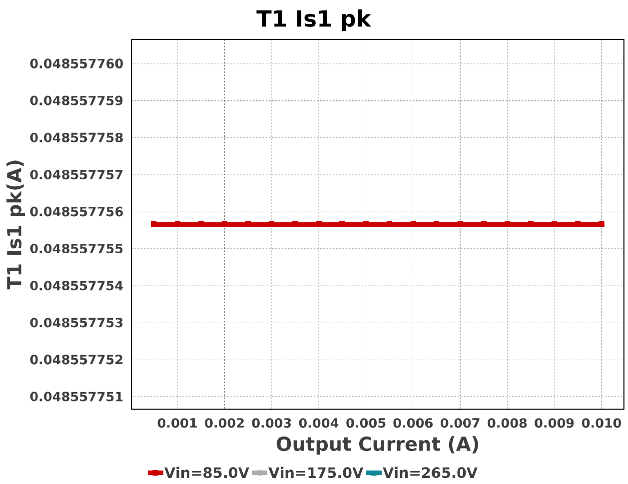

T1 Copper Loss
T1 Copper Loss(W)
0.300 0.275 0.250 0.225 0.200 0.175 0.150 0.125 0.100 0.075 0.050 0.025 0.000
0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.010
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

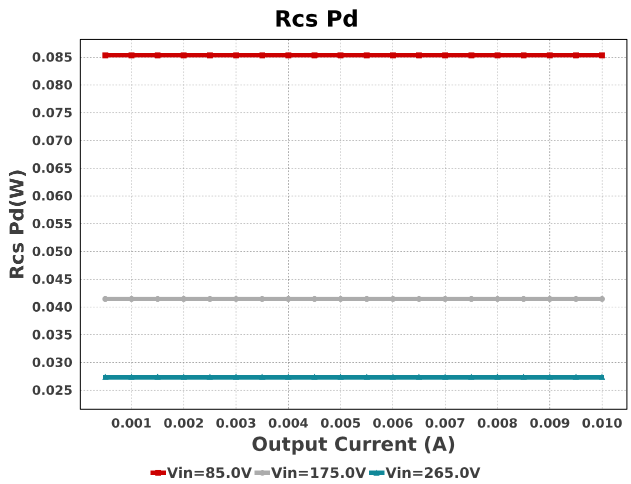

Cout IRMS
Cout IRMS(A)
0.0217
0.0216
0.0215
0.0214
0.0213
0.0212
0.0211
0.0210
0.0209
0.0208
0.0207
0.0206
0.0205
0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.010
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

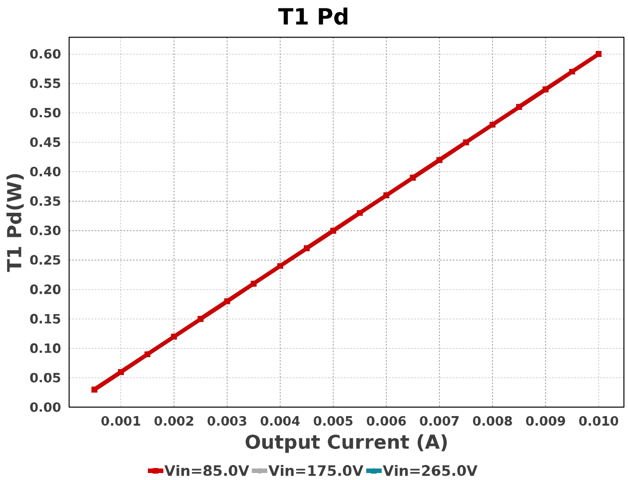

Avg Bridge Diode Pd
Avg Bridge Diode Pd(W)
0.300
0.275
0.250
0.225
0.200
0.175
0.150
0.125
0.100
0.075
0.050
0.025
0.000
0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.010
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V

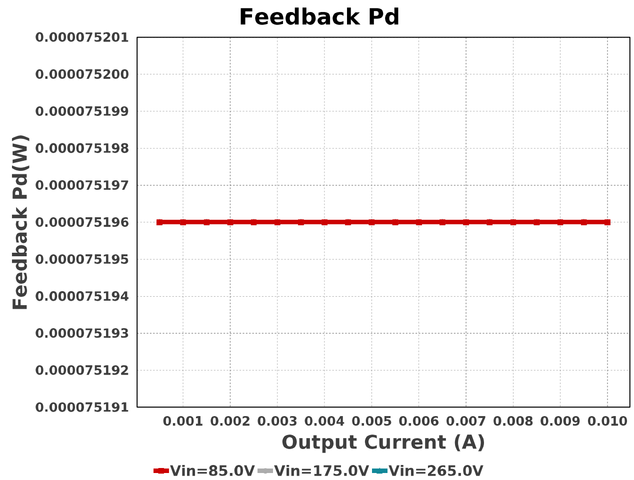

IC Pd
IC Pd(W)
0.000890054
0.000890053
0.000890052
0.000890051
0.000890050
0.000890049
0.000890048
0.000890047
0.000890046
0.000890045
0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.010
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V


Avg Rectified Vin
Avg Rectified Vin(V)
300
275
250
225
200
175
150
125
100
75
0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.010
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V


T1 Is1 pk
T1 Is1 pk(A)
0.048557760
0.048557759
0.048557758
0.048557757
0.048557756
0.048557755
0.048557754
0.048557753
0.048557752
0.048557751
0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.010
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V


Rcs Pd
Rcs Pd(W)
0.085
0.080
0.075
0.070
0.065
0.060
0.055
0.050
0.045
0.040
0.035
0.030
0.025
0.001 0.002 0.003 0.004 0.005 0.006 0.007 0.008 0.009 0.010
Output Current (A)
Vin=85.0V Vin=175.0V Vin=265.0V





Operating Values

#	Name	Value	Category	Description
1.	Cin Pd	4.844 mW	Capacitor	Input capacitor power dissipation
2.	Cin2 IRMS	512.748 mA	Capacitor	Input Capacitor Cin2 RMS Ripple Current
3.	Cout IRMS	20.717 mA	Capacitor	Output capacitor RMS ripple current
4.	Cout Pd	42.918 nW	Capacitor	Output capacitor power dissipation
5.	Avg Bridge Diode Pd	289.46 mW	Diode	Average Power Dissipation in the Bridge Diode over the AC Line Period
6.	Diode2 Pd	5.962 mW	Diode	Diode2 power dissipation
7.	IC Pd	890.05 µW	IC	IC power dissipation
8.	IC Tj	30.134 degC	IC	IC junction temperature
9.	ICThetaJA	150.0 degC/W	IC	IC junction-to-ambient thermal resistance
10.	M1 Pd	20.886 mW	Mosfet	M1 MOSFET total power dissipation
11.	M1 TjOP	31.099 degC	Mosfet	M1 MOSFET junction temperature
12.	Avg Bridge Diode Pd	289.46 mW	Power	Average Power Dissipation in the Bridge Diode over the AC Line Period
13.	Cin Pd	4.844 mW	Power	Input capacitor power dissipation
14.	Cout Pd	42.918 nW	Power	Output capacitor power dissipation
15.	Diode2 Pd	5.962 mW	Power	Diode2 power dissipation
16.	Feedback Pd	75.196 µW	Power	Power Dissipation in Feedback Resistors
17.	IC Pd	890.05 µW	Power	IC power dissipation
18.	M1 Pd	20.886 mW	Power	M1 MOSFET total power dissipation
19.	Rcs Pd	85.344 mW	Power	Power Dissipation in Current Sense Resistors
20.	Snubber Pd	352.981 mW	Power	Snubber Power Dissipation
21.	T1 Copper Loss	300.0 mW	Power	Transformer Copper Loss Power Dissipation
22.	T1 Core Loss	300.0 mW	Power	Transformer Core Loss Power Dissipation
23.	T1 Pd	600.0 mW	Power	Estimated Losses in Transformer
24.	Total Pd	1.535 W	Power	Total Power Dissipation
25.	Feedback Pd	75.196 µW	Resistor	Power Dissipation in Feedback Resistors
26.	Rcs Pd	85.344 mW	Resistor	Power Dissipation in Current Sense Resistors
27.	Avg Rectified Vin	94.665 V	System Information	Average Rectified Voltage for the AC Line Period
28.	BOM Count	34	System Information	Total Design BOM count
29.	Duty Cycle	52.767 %	System Information	Duty cycle
30.	Efficiency	86.696 %	System Information	Steady state efficiency
31.	FootPrint	1.571 k mm^2	System Information	Total Foot Print Area of BOM components
32.	Frequency	100.0 kHz	System Information	Switching frequency
33.	Iin rms	135.7 mA	System Information	RMS Input Current
34.	Iout	10.0 mA	System Information	Iout operating point
35.	Min Rectified Vin	69.124 V	System Information	Minimum voltage seen at rectified input
36.	Mode	DCM	System Information	Conduction Mode
37.	Peak Rectified Vin	120.207 V	System Information	Peak voltage seen at rectified input
38.	Pout	10.0 W	System Information	Total output power
39.	Total BOM	NA	System Information	Total BOM Cost

#	Name	Value	Category	Description
40.	Vin_RMS	85.0 V	System Information	Vin operating point
41.	Vout Actual	975.0 V	System Information	Achieved Vout with feedback resistor pair
42.	Vout Tolerance	8.0 m%	System Information	Vout Tolerance based on IC Tolerance (no load) and voltage divider resistors if applicable
43.	T1 Copper Loss	300.0 mW	Transformer	Transformer Copper Loss Power Dissipation
44.	T1 Core Loss	300.0 mW	Transformer	Transformer Core Loss Power Dissipation
45.	T1 Iprim RMS	259.23 mA	Transformer	Transformer Primary RMS Current
46.	T1 Iprim pk	618.11 mA	Transformer	Transformer Primary Peak Current
47.	T1 Is1 RMS	21.979 mA	Transformer	Transformer Secondary1 RMS Current
48.	T1 Is1 pk	48.613 mA	Transformer	Transformer Secondary1 Peak Current
49.	T1 Pd	600.0 mW	Transformer	Estimated Losses in Transformer

Design Inputs

Name	Value	Description
Iout	10.0 m	Maximum Output Current
VinMax	265.0	Maximum input voltage
VinMin	85.0	Minimum input voltage
Vout	1,000.0	Output Voltage
acFrequency	60.0	AC Frequency
base_pn	UCC28742	Base Product Number
source	AC	Input Source Type
Ta	30.0	Ambient temperature

WEBENCH® Assembly

Component Testing

Some published data on components in datasheets such as Capacitor ESR and Inductor DC resistance is based on conservative values that will guarantee that the components always exceed the specification. For design purposes it is usually better to work with typical values. Since this data is not always available it is a good practice to measure the Capacitance and ESR values of Cin and Cout, and the inductance and DC resistance of L1 before assembly of the board. Any large discrepancies in values should be electrically simulated in WEBENCH to check for instabilities and thermally simulated in WebTHERM to make sure critical temperatures are not exceeded.

Soldering Component to Board

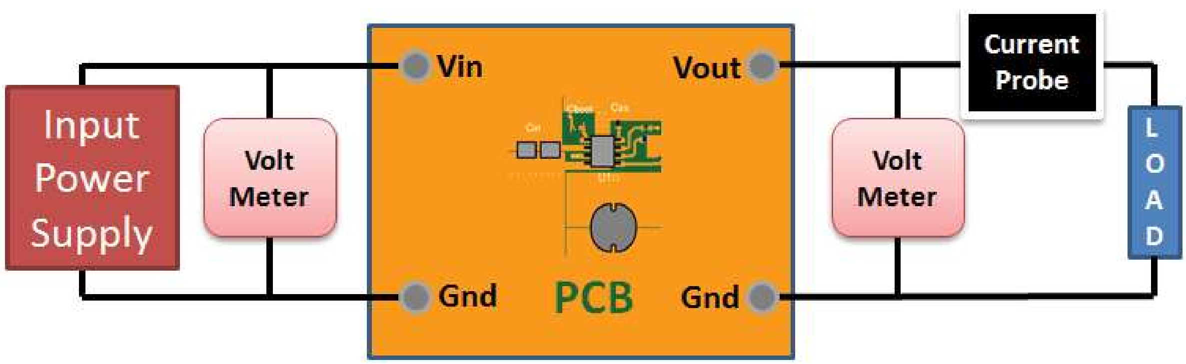
If board assembly is done in house it is best to tack down one terminal of a component on the board then solder the other terminal. For surface mount parts with large tabs, such as the DPAK, the tab on the back of the package should be pre-tinned with solder, then tacked into place by one of the pins. To solder the tab town to the board place the iron down on the board while resting against the tab, heating both surfaces simultaneously. Apply light pressure to the top of the plastic case until the solder flows around the part and the part is flush with the PCB. If the solder is not flowing around the board you may need a higher wattage iron (generally 25W to 30W is enough).

Initial Startup of Circuit

It is best to initially power up the board by setting the input supply voltage to the lowest operating input voltage 85.0V and set the input supply's current limit to zero. With the input supply off connect up the input supply to Vin and GND. Connect a digital volt meter and a load if needed to set the minimum Iout of the design from Vout and GND. Turn on the input supply and slowly turn up the current limit on the input supply. If the voltage starts to rise on the input supply continue increasing the input supply current limit while watching the output voltage. If the current increases on the input supply, but the voltage remains near zero, then there may be a short or a component misplaced on the board. Power down the board and visually inspect for solder bridges and recheck the diode and capacitor polarities. Once the power supply circuit is operational then more extensive testing may include full load testing, transient load and line tests to compare with simulation results.

Load Testing

The setup is the same as the initial startup, except that an additional digital voltmeter is connected between Vin and GND, a load is connected between Vout and GND and a current meter is connected in series between Vout and the load. The load must be able to handle at least rated output power + 50% (7.5 watts for this design). Ideally the load is supplied in the form of a variable load test unit. It can also be done in the form of suitably large power resistors. When using an oscilloscope to measure waveforms on the prototype board, the ground leads of the oscilloscope probes should be as short as possible and the area of the loop formed by the ground lead should be kept to a minimum. This will help reduce ground lead inductance and eliminate EMI noise that is not actually present in the circuit.



Design Assistance

1. Master key : BEB737F2C9F6AAE28D8DDDFB9880363E[v1]

2. **UCC28742** Product Folder : http://www.ti.com/product/UCC28742 : contains the data sheet and other resources.

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